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Noon

REMARKS

TO THE

FUSION FORUM LUNCHEON
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by

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How DOE and the Clinton Administration view Fusion Energy development

Importance of a Strong, Secure Energy Future

The current upward price spike in gasoline prices reminds us once again -- our economy runs on energy. When energy price or supply instabilities appear on our economic radar, everyone pays attention because everyone pays the price -- higher costs at the gas pump -- higher prices for food and other products transported from farm or factory to market -- higher heating costs for business, school and home heating and cooling -- the list goes on.

James Schlesinger, the first Secretary of Energy, has said, **"By the end of this decade, we are likely to see substantial price increases."**

Donald Hodel, Secretary of Energy under President Reagan, has said that we are **"sleepwalking into a disaster"** and predicts a major oil crisis within a few years.

But when prices are low, as they have been in recent years, we tend to believe that the market is operating as it should and that those prices will continue.

One job of the Department of Energy is to support science and technology that can lessen economic impacts of short term energy supply problems and will ensure development of long term energy options to power our economy well into the next century.

Need for Environmentally Safe Energy Resources

In the room today with us are examples of a big reason why we also want our energy resources to be clean and environmentally safe -- our children. We know that students of all ages express concern about the environment when questioned and we want our energy legacy to them to be clean and safe. Basic scientific research can help that happen and it is important that our government supports a portfolio of scientific study.

Li Cheung from **Oxon Hill High School** -- has a 4 year scholarship to **Duke University** -- received the **Outstanding Science Student Award** -- he has done award winning work for science fairs on **solar cells**.

Sara Olsen also from **Oxon Hill High**, received the **Scholar Athlete Award** -- a **Science Fair Grand Award** winner -- she will attend the **University of Rochester** on an **ROTC** scholarship.

Joe Lucas, their valedictorian, was a **Grand Award Winner at the International Science and Engineering Fair**.

These students are the future of our nation -- our intellectual capital return on investment. They are the people who will complete much of the research now under way, or just beginning.

They are the men and women who will identify and begin research in the next century. And they are the sons and daughters for whom we wish to leave a safer, cleaner world with much hope and promise ahead.

It is for them that we plan and for them that we work hard to find the best answers to all of the tough questions.

DOE's Portfolio of Energy Options

We believe that basic science and technology research has served us well in development of our current energy options portfolio. We support development of Sustainable Technologies including renewable energy and energy efficiency.
We believe sustainable development is key to long-term economic growth that creates jobs while improving and preserving our environment. This type of development is possible through the innovative use of energy and environmental technologies.

Energy efficiency technologies ensure that existing sources of energy will last longer and be more productive. Thanks to energy efficiency, from 1977 to 1987, energy use in the United States actually decreased slightly while the gross national product increased 27 percent in real dollars. (Source: DOE/EE)

Improved efficiency means that the economic costs of energy consumption will be better absorbed and better managed by business, industry and consumers. Better energy efficiency means a cleaner environment, but it can mean good business for America as well.

A study by the American Council for an Energy Efficient Economy (1992) said that a high efficiency scenario for the U.S. would create 471,000 new jobs by the turn of the century and 1.1 Million new jobs by 2010.

The potential energy efficiency market in Eastern Europe, for example, has been estimated at $20 Billion. And the U.S. is home to the best in energy efficiency technologies ready for export.

Renewable energy resources such as solar and wind are good examples of sustainable technologies that are cost effective in many situations already -- with promise for expanded roles in the future. They are clean and they will never be "used up."

Solar thermal electric systems operating in the U.S. today, meet the needs of 350,000 people and displace the equivalent of 2.3 Million barrels of oil

annually. Global energy markets for renewables are estimated at $15 Billion by the year 2000 (Source: DOE).

Fossil fuels such as oil and natural gas are relatively clean. Even coal must be a part of the mix, using clean coal technologies developed with DOE support. While they are finite resources, we can use them efficiently, as long as possible, while we develop other long term energy sources.

Existing nuclear energy technologies will continue to be a significant part of the energy resource mix. But public concerns about proliferation, safety, and waste disposal are likely to continue to limit the growth of this source.

Fusion is a long term option that must be developed, since world energy demand will grow rapidly -- mostly in the developing nations -- over the next 20 years -- because we know that total energy available from conventional sources will not meet the expected growth in energy demand.

By 2010, world wide energy consumption is expected to increase by about 15 percent to approximately 3554 Million Tons of Oil Equivalent, according to the International Energy Agency's 1995 World Energy Outlook Capacity Constraints Case.

Fortune magazine notes that, by the year 2020, if the per capita energy consumption in China and India rises to that of South Korea today -- when considered with expected population growth, "these two countries alone will need a total of 119 Million Barrels of Oil a day. That's almost DOUBLE the WORLD'S entire demand today."

We believe that one way to plan to meet that demand, and to do it without increased production of greenhouse gases, is to continue our fusion science research and to support our role in international fusion research.

Why Fusion?

Fusion is our longest term option that shows significant promise.

Fusion research is exactly the kind of program government should support. The payback period is long term. Industry can't and won't do it alone because of the payback period and because of high front end costs.

Working with universities and high-tech industries, using the unique capabilities of the national laboratories, DOE can bring together resources for progress in a well-managed, cost effective program.

Vice President Gore, in Earth in the Balance, noted that "...research and development should continue vigorously, especially in technologies like fusion power, which offer the prospect, however distant, of somewhat safer and more abundant sources of electricity."

Fusion promises a universally available, essentially inexhaustible, efficient fuel resource -- with attractive safety and environmental characteristics that can meet growing global energy demands.

Progress in Fusion

Fusion as a practical technology sometimes seems a remote possibility, but we know from history that the future is always closer than we might think.

When William Gladstone asked Michael Faraday what the practical worth of electricity was, Faraday replied, "One day, sir, you may tax it."

Or as Nobel Laureate, Leon Lederman, put it more recently, "The lessons of history are clear -- the more exotic, the more abstract the knowledge, the more profound will be its consequences."

Progress in fusion research has been steady and dramatic. Over the past 20 years, the fusion power equivalent produced in experimental devices has increased over 100 million-fold -- from 0.1 watt in 1975 to more than 10 million watts in 1995. This rate of progress far outstrips the rate of progress -- for example -- in increased capacity of semi-conductor chips -- a product more people are familiar with.

Spin-offs

Spin-offs from the new field of plasma physics fostered by DOE's fusion research and driven by DOE research funding are already impressive.

One fusion spin-off that has won one of the prestigious R & D 100 awards -- the Microwave Plasma Continuous Emissions Monitor tracks toxic metals emitted from incinerators and furnaces used for waste processing.

This tracking ensures compliance with environmental regulations and provides for possible control of toxic emissions. Researchers at the Massachusetts Institute of Technology who developed the device used microwave research that is part of a DOE Office of Fusion Energy Sciences diagnostic development program.

This is the Second Year in a Row that M.I.T. Plasma Fusion Center researchers have won an R & D 100 Award for work related to a fusion research spin-off.

General Motors expects to attain longer lifetimes for metal car parts and manufacturing tooling from plasma source ion implantation. Working with Los Alamos National Lab and the University of Wisconsin, improvements in the hardness of materials used of more than 65 times that of untreated material, and reductions in friction of one-half have been made. In bench tests, wear life was extended more than 25 times that of materials not treated with the plasma source ion implantation.

This new type of ion implantation/deposition technique quickly, simply and cost-effectively treats complicated shapes at low temperatures. Analysis of comprehensive costs -- including amortized capital equipment, personnel, consumables -- shows that large-scale treatment adds up to less than half a cent per square centimeter -- typically 100-times less than traditional techniques.

This technology is going commercial any day. The first industrial Plasma Source Ion Implantation system was built by North Star Research Corporation in Albuquerque, New Mexico, and is undergoing shakedown trials now at Empire Hard Chrome, Inc., in Chicago. It will be used for chrome plated dies for heavy manufacturing.

The benefits to U.S. industries from access to this technology is enormous -- the annual U.S. domestic market for machine tools alone is $5 Billion, of which approximately 50 percent is now supplied from overseas. Companies as diverse as Harley-Davidson and Litton are interested in this new version of plasma source ion implantation, as is the U.S. Navy -- for improvements in wear and corrosion properties of military systems.

Advanced computer chip manufacturing --

Plasma processes are used to produce finer detail needed to increase computer chip capacity. To put 5 million transistors on a Pentium chip plasma processes are needed for nearly half the steps involved in making the chip. The estimated world market for high performance chips and circuits exceeds $30 Billion/year.

Bob Conn, outgoing chair of the Fusion Energy Advisory Committee, along with one of his students at UCLA, graduate student, Greg Campbell -- saw the potential for use of plasmas to manufacture computer chips. They formed Plasma Materials Technologies, Inc. in 1986. In 1995 sales were $21.3 Million -- double that of 1994.

Other products already applying plasma research are: flat panel displays such as moving maps and plasma switches for electricity transmission, both part of the huge new industry using plasma electronics -- and new, efficient technologies for destruction or vitrification of toxic and radioactive wastes -- for a world market estimated to be worth in excess of $50 Billion/year.

The development of plasma science has had impact on: astrophysics -- supercomputer networking -- lasers -- numerical computation and modeling -- nonlinear dynamics and chaos.

The U.S. role in international fusion research efforts

Fusion research today is a wonderful example of international cooperation across a broad spectrum of research. The U.S.. is no longer the dominant player, with our program accounting for about one-fifth of the world's investment in fusion.

The other four-fifths come from the European Community, providing just under one-half of the total one and a quarter Billion dollars international fusion research contribution, Japan, providing about one-third of the total, and the Russian Federation and others accounting for the balance.

Major focus at this time is aimed at designing and building the International Thermonuclear Experimental Reactor (ITER) to demonstrate the scientific and technological feasibility of fusion. This is expected to lead, eventually, to a demonstration reactor for the production of electricity from fusion and eventually to commercial reactors. The ITER is a unique international cooperative effort among four equal partners: the U.S., the European Community, Japan, and the Russian Federation.

All of the international partners are in the process of deciding whether to move toward construction of the ITER. Estimates are that the experimental reactor will cost about $10 Billion to build, thus, no single partner can bear the financial burden. We are working together on the design work for this reactor which is expected to be completed by July 1998.

Vital international role

Why is it vital for the U.S. to preserve our commitment to international fusion research?

We have signed agreements which we must honor. Our participation in the International Thermonuclear Experimental Reactor partnership began in 1987. It has survived the dramatic historic transition that saw one partner -- the Soviet Union -- become the Russian Federation. If other partners could continue to meet their obligations during such upheavals, we must be prepared to do the same.

The U.S. can no longer afford large capital investments to accommodate fusion experiments. Through international partnerships we can share in the knowledge that comes from the building and operation of multi-billion dollar devices by sharing in the planning, design, cost, and construction of them.

We must maintain our scientific strengths to be a viable international player. The U.S. excels in many areas of fusion research including diagnostics, fusion theory, and computer modeling. We bring those areas of expertise to the table in any fusion research context, but without a strong domestic program, we will fall behind our partners.

We can develop advanced diagnostic devices to monitor experiments on experimental facilities to be built abroad. We need a strong fusion program to do that, to know what such devices should do and how to build them. Then, when results come back from international research projects, we will be in a position to evaluate them and go forward.

Participation in international fusion research and continuation of our own U.S. fusion science program is important to states, universities and national labs -- some 35 states and 30 universities are involved.

From Auburn University in Alabama, with the only operating stellarator -- an alternative fusion device -- in the U.S., to little Prairie View A & M in Texas which is conducting experiments in support of the International Thermonuclear Experimental Reactor -- to the University of Wisconsin at Madison that developed the capability to operate experiments at the Tokamak Fusion Test Reactor in Princeton, NJ via the Internet, -- U.S. colleges and universities are plugged into fusion research that DOE supports.

Budget Status and Program Impacts

I will leave the budget details to Martha Krebs, but there are a couple of points I will make.

The fusion science program was cut by one-third last year. At the direction of Congress we have restructured the fusion program's strategy, content and near-to-medium term objectives.

We were aided in this task by the Fusion Energy Advisory Committee. Advisory committee members included university, corporate and national laboratory representatives, thoroughly versed in the elements and realities of fusion research.

In its report to Dr. Krebs, dated January 27, 1996, the Committee expressed conviction that "the United States must field a program that seizes the opportunities of today, in a restructured format, to promote progress in fusion science and technology. This is a time of tremendous progress and opportunity in fusion."

Or as George Will put it in a column about the importance of ideas in determining the course of history: "Only ideas have large and lasting consequences...Perhaps a century from now notice will still be taken of what happened around midnight, December 9, 1993, at the Princeton Plasma Physics Laboratory... A team of scientists operating a test reactor produced pulses of energy from controlled fusion...up to several million watts of power. The task of producing in New Jersey the process that powers the sun (which in turn powers New Jersey) is not to be sneezed at..."

Our fusion budget request ($264 Million total) is BARE BONES to support the elements of a restructured fusion program. Our new fusion focus is toward less costly critical basic science and technology foundations and away from the expensive path of fusion power plant development driven by the calendar. Taking away the milestone dates for energy technology development relieves budgetary pressures somewhat.

There are no major construction projects on the horizon. By reducing the out year mortgages associated with construction projects, for example, our funding levels can remain modest.

But by focusing on science -- we can continue to make progress and maintain strengths that allow the U.S. to participate and benefit from the international program.

How is DOE responding to changed program direction?

Our new mission statement: "Advance plasma science, fusion science, and fusion technology -- the knowledge base needed for an economically and environmentally attractive fusion energy source."

Our policy goals are to:

o Advance plasma science in pursuit of national science and technology goals.

o Develop fusion science, technology, and plasma confinement innovations as the central theme of the domestic program.

o Pursue fusion energy science and technology as a partner in the international effort

As a practical matter, we still see important research spin-offs continuing for the near term and we can still make results oriented progress for fusion energy technology in the future.

The President's budget request is consistent with the restructured program, our new mission statement and is built around the three policy goals.

We are still able to utilize several Billion dollars worth of existing capital investment. The Tokamak Fusion Test Reactor at Princeton Plasma Physics Lab will be shut down no later than 1998 -- flat budgets dictate that action.

We can also provide incremental funding to pursue basic plasma science, and plasma-containment research, and achieve greater use of D-three-D, the tokamak machine near San Diego, California and the Alcator-C tokamak at the Massachusetts Institute of Technology.

Below $264 Million it would not be possible to implement the goals of the restructured program, including honoring our international commitments to the engineering design activity on the International Thermonuclear Experimental Reactor.

The U.S. can still play an important supporting role in magnetic fusion energy development, but only by recognizing our increased dependence on the activities and decisions of Europe, Japan and the Russian Federation.

Continued progress will depend on maintaining a balance of domestic and international activities.

We have done what the Congress asked us to do. We restructured and reoriented our fusion program and we have submitted a supporting budget that makes sense. We believe that a strong fusion science program is in the best long-term scientific and energy interests of the United States.

As Dr. Jack Gibbons, President Clinton's Science Advisor, put it, "The tremendous potential payoffs of fusion energy and the large scale of fusion experimental technology, combined with recent impressive technical achievements in the program, indicate that fusion remains an important and appropriate activity for the Federal government within the Department of Energy."

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